BIOLOGICAL EVALUATION OF GYPSY MOTH

at the

Beltsville Agricultural Research Center

2001

Prepared by

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ABSTRACT

On October 23-25, 2001, USDA Forest Service personnel conducted a gypsy moth egg mass survey at the Beltsville Agricultural Research Center (BARC) to assess the potential for defoliation and the need for treatment in 2002. Current populations are sufficient to cause noticeable defoliation on approximately 410 acres. Treatment is recommended to prevent defoliation and possible tree mortality.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a $1/40^{th}$ acre fixed radius plot was established. The plots consisted of a tally of all new (2001) egg masses observed on overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. The average egg mass length (measured in millimeters) and egg mass density (egg masses per acre) were used to estimate defoliation potential (Liebhold et al., 1993).

RESULTS

The location of the survey plots are shown in Figure 1. The summarized results of the survey are presented in Table 1. Egg mass densities throughout BARC ranged from 0-3,800 and averaged 644 egg masses per acre. Gypsy moth populations are higher in the western half of BARC as egg mass densities west of Rt. 295 averaged 1,006 egg masses per acre while egg mass densities east of Rt. 295 averaged only 182 egg masses per acre. Overall egg mass lengths tended to be large to extra large in size, ranged from 23-54 mm and averaged 32 mm.

Table 1. – Gypsy moth egg mass survey results at the Beltsville Agricultural Research Center, October 23-25, 2001.

Plot Number	Number EM/Acre	Plot Number	Number EM/Acre
1 *	1,600	34	80
2 *	3,080	35	0
3 *	3,800	36	0
4	680	37	280
5	0	38	200
6*	2,520	39	0
7*	2,040	40	40
8*	600	41	80
9	280	42	0
10	3,080	43	680
11	0	44	40
12	40	45	40
13	640	46	400
14	1,360	47	0
15	120	48	0
16*	2,240	49	40
17*	2,000	50	840
18 *	1,280	51	680
19*	640	52	160
20*	80	53	80
21*	280	54	160
22*	1,640	55	360
23	80	56	0
24	400	57	0
25	240	58	120
26	0	59	1,040
27*	1,360	60	40
28*	0	61	0
29*	2,640	62	240
30*	2,200	63	40
31*	1,200	64	0
32*	720	65	0
33	40	66	0

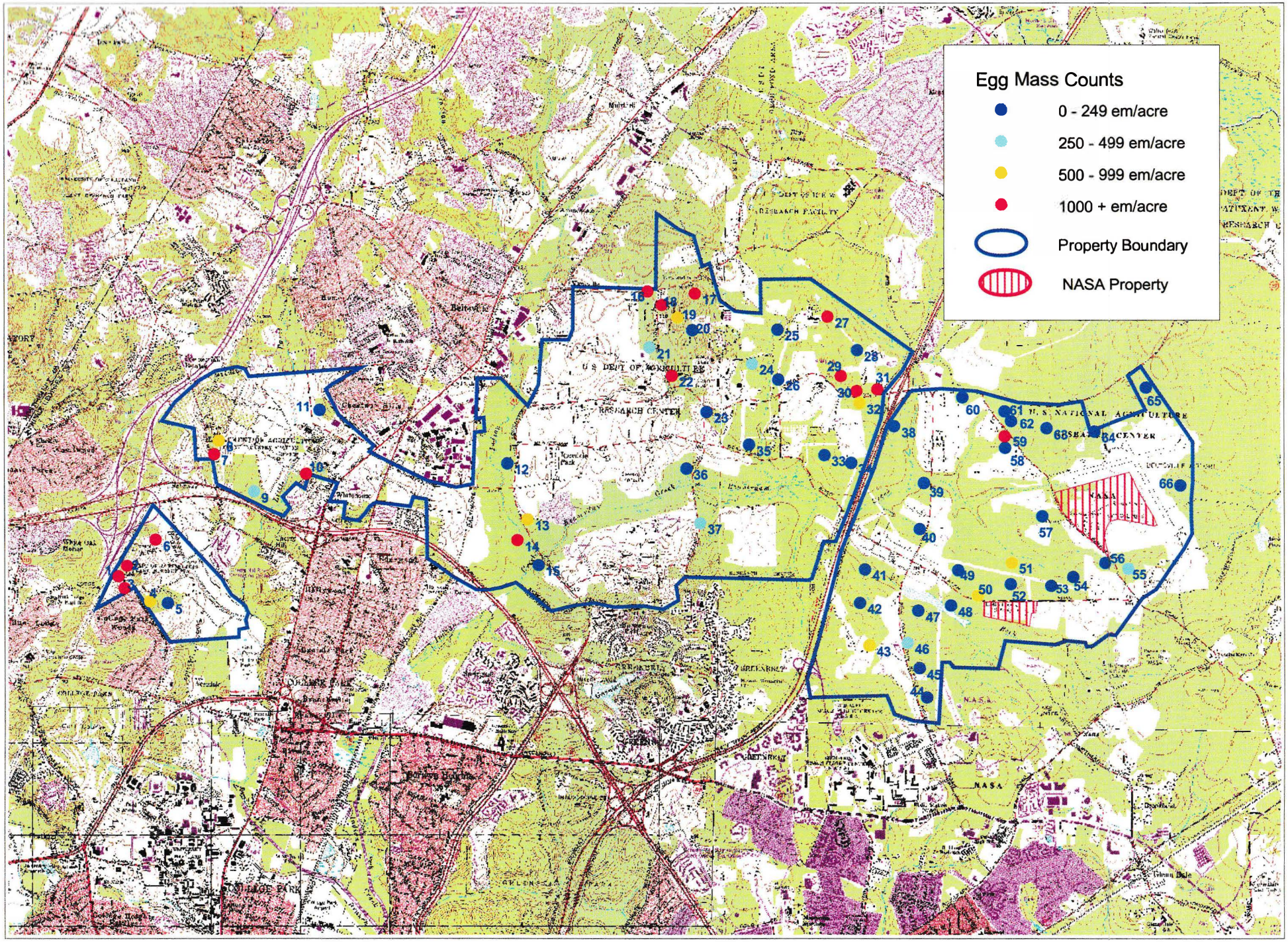
Overall egg mass/acre range = 0-3,800
Overall egg mass/acre average = 644

Egg mass size range (mm) = 23-54
Egg mass size average (mm) = 32

* = located within proposed treatment blocks

Egg mass/acre range in proposed treatment blocks = 0-3,800
Egg mass/acre average in proposed treatment blocks = 1,575

Figure 1.-- Gypsy moth survey plot locations at the Beltsville Agricultural Research Center, October 23-25, 2001.



DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (1-30 percent); moderate (31-60 percent); and heavy (61-100 percent).

The survey results indicate that moderate defoliation is likely to occur on six areas encompassing approximately 410 acres in the western half of BARC in 2002 (Figure 2). Four of the areas, totaling only 37 acres, are small woodlots located west of MD Rt.1. The larger two areas encompassing approximately 373 acres, are located near Powder Mill Road.

This conclusion is further supported when egg density is used as a means of predicting defoliation. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and predicting defoliation. Using Liebhold's model, Figure 3 shows how this information can be used to correlate the predicted defoliation of an area. Accordingly, the estimated egg mass density of 2,273 egg masses per acre (average egg mass density in the four small woodlots west of MD Rt.1) x 32 mm (average egg mass length) translates to a projected defoliation level of about 60 percent (moderate defoliation). Because egg mass densities and host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately moderate throughout these areas of BARC. Moderate defoliation (39 and 42 percent, respectively) is also projected in the Powder Mill Road blocks. Elsewhere at BARC, defoliation is not expected to be of significance.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy throughout most areas surveyed at BARC. The average egg mass length is 32 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. There was no evidence that either one of these entomopathogens had significant impacts at BARC in 2001. Although it is still possible that either the gypsy moth fungus or the NPV could cause a general collapse next year, it is not likely to occur prior to a significant defoliation event occurring in 2002.

Predicting the extent of tree mortality that would result after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light-moderate defoliation (< 60 percent) are not likely to refoliate and there is probably no significant

Figure 2. -- Areas where gypsy moth defoliation is likely/Proposed treatment blocks for 2002.

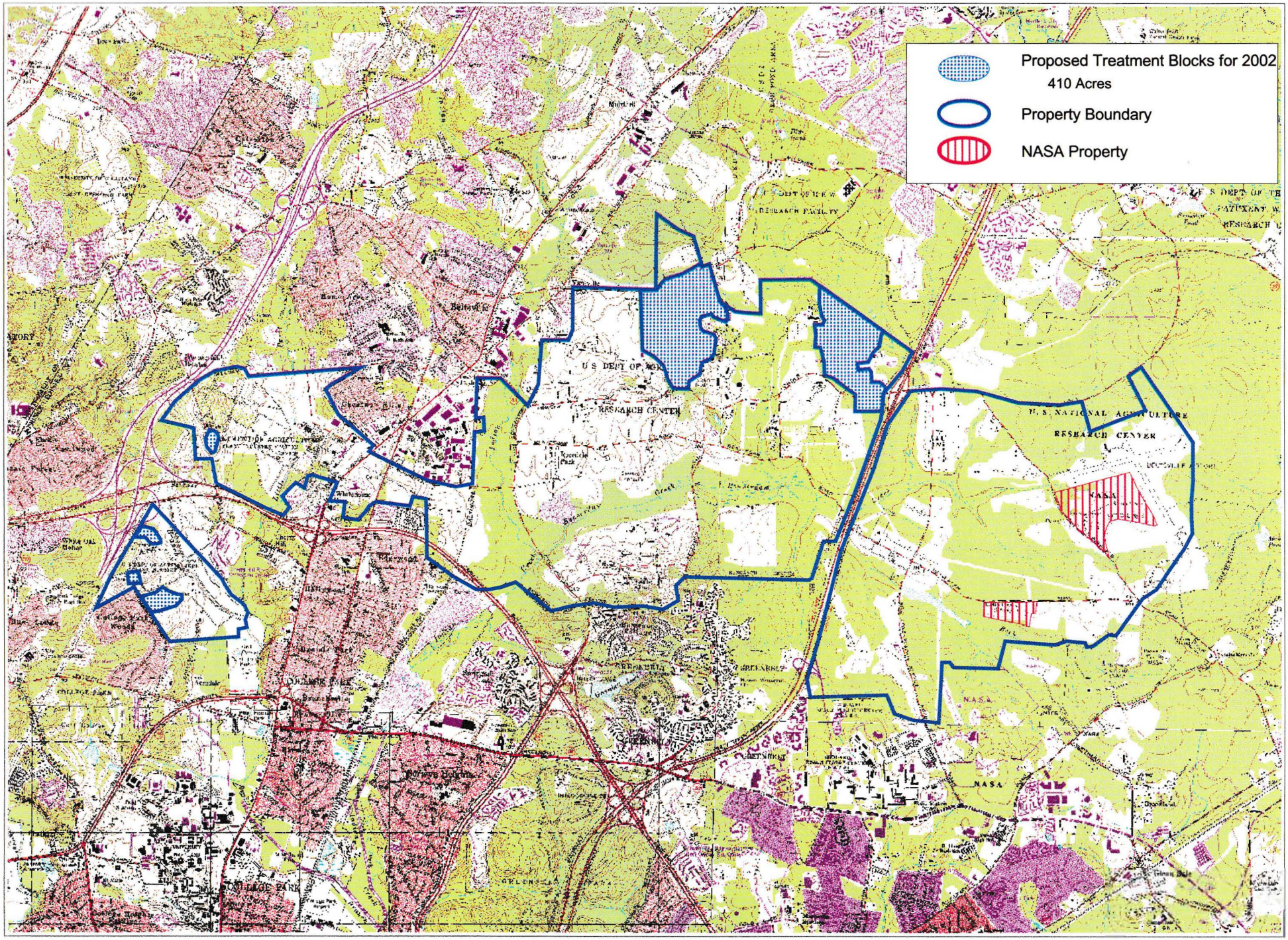
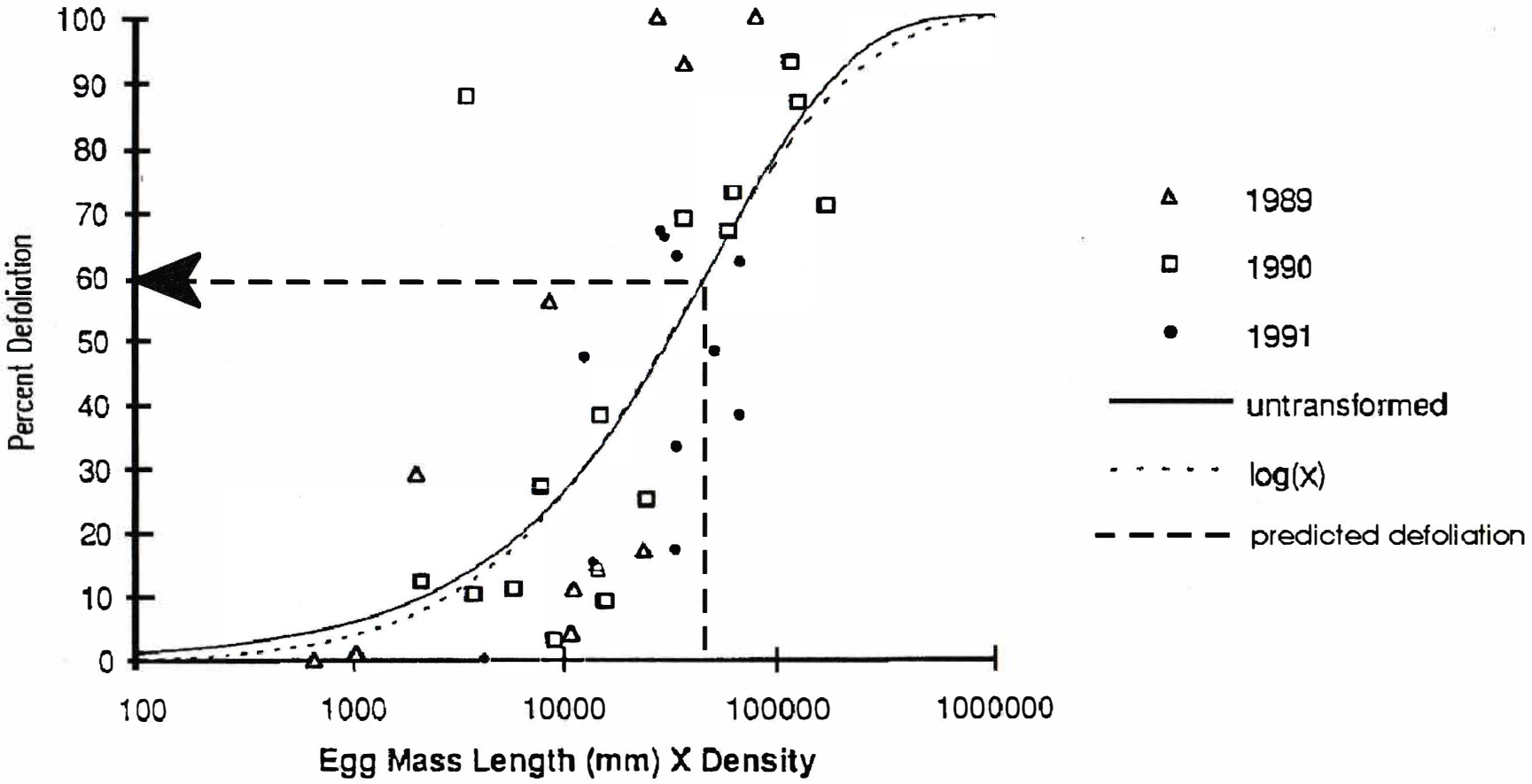


Figure 3.--Predicted defoliation in 4 small woodlots west of MD Rt. 1 at BARC in 2002



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. Droughty conditions have been experienced in this portion of Maryland during the summer months in 1995, 1997, 1998 and 1999. However, adequate rainfall occurred during the last two growing seasons. Gypsy moth defoliation has not been detected at BARC over the last several years.

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) provide examples of potential tree mortality. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28) percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak sawtimber and 14 percent of the total oak poletimber occurred after one year of moderate to heavy defoliation. In these examples, droughty conditions likely contributed to the level of mortality.

Based on observations of the existing health of the forested areas at BARC and the factors mentioned above, large areas of extensive tree mortality are not expected should defoliation occur in the absence of drought conditions in 2002.

Management Options

For 2002, two management options have been evaluated for managing gypsy moth populations at BARC. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent mast failure and tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga.* In areas with defoliating levels of gypsy moth populations (greater than 750 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels

Although it is not possible to accurately assess such events with information at hand, it is unlikely that a collapse will occur prior to defoliation since most of these areas are newly infested and there is an abundance of large healthy egg masses.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al. (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that moderate defoliation will occur in six areas located in the western portion of BARC in 2002.

Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk).* This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al. (1996) in West Virginia. Miller's study involved a large-scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1-year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½-1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population

(building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 2×10^{11} occlusion bodies (OB's) per acre applied in two applications, 3-5 days apart. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There are, however, sufficient quantities of Gypchek currently available for 2002 should this insecticide be preferred for use at BARC.

Alternatives

With the previously described options in mind, the following alternatives are offered.

Alternative 1.	-No action
Alternative 2.	-One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre.
Alternative 3	-Two aerial application of *Btk*, as in alternative 2, applied 4-7 days apart.
Alternative 4	-Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations in six areas in the western half of BARC are healthy, building and sufficient to cause moderate defoliation in 2002. To protect tree foliage

and prevent subsequent tree mortality, our recommendation is for either Alternative 2 (a single application of *Btk*) or alternative 4 (double application of Gypchek). Unless there is sufficient cause for concern regarding potential impacts of *Btk* to non-target lepidopterous larvae, a single application of *Btk* is the preferred recommendation.

This recommendation is based on the following considerations.

1) It is likely that a single application of *Btk* will provide adequate foliage protection and sufficiently reduce existing densities below the treatment threshold of 750 egg masses/acre.

2) A double application of Gypchek would likely provide adequate foliage protection and sufficient population reduction.

3) The cost of a single application of *Btk* is about one half that of a double application of Gypchek.

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File Code: 3400
Date: January 4, 2002

Mr. Kevin Thorpe
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Dear Mr. Thorpe:

Enclosed is the gypsy moth biological evaluation for the Beltsville Agricultural Research Center.

In brief, gypsy moth populations are sufficient to cause moderate defoliation on 410 acres in the western half of BARC. We are recommending a single application of *Bacillus thuringiensis* variety *kurstaki (Btk)* in these 6 areas. With proper application, gypsy moth defoliation should be minimal at BARC in 2002.

Please contact Rod or Brad at (304) 285-1541 if you have any questions concerning the gypsy moth biological evaluation.

Sincerely,

JOHN W. HAZEL
Field Representative
Morgantown Field Office

Enclosure

Cc: Robert Tichenor, MDA
Sally Hughes, MDA
Bernie Raimo, DFO
Mike Connor, SPFO
Noel Schneeberger, AO

JWH/RLW/blm